

WHAT IS CLAIMED IS:

1. A field-emission electron source comprising:
a substrate,
an insulating layer that is formed on the substrate and has a plurality of openings,
cathodes arranged at the respective openings to emit electron beams,
a lead electrode formed on the insulating layer to control emission of the electrons from the cathodes; and
a surface-modifying layer formed on the surface of each of the cathodes emitting the electrons, comprising a chemical bond between a cathode material composing the cathodes and a material different from the cathode material.
2. The field-emission electron source according to claim 1, wherein the cathodes comprise silicon.
3. The field-emission electron source according to claim 1, wherein the surface-modifying layer comprises a chemical bond between the cathode material and a material whose sputtering rate with respect to argon is lower than a sputtering rate of the cathode material.
4. The field-emission electron source according to claim 1, wherein the surface-modifying layer comprises a chemical bond between silicon and carbon.
5. The field-emission electron source according to claim 1, wherein the substrate comprises silicon.
6. The field-emission electron source according to claim 1, wherein the cathodes comprise molybdenum.
7. The field-emission electron source according to claim 1, wherein the cathodes are arrayed on the substrate.
8. The field-emission electron source according to claim 1, wherein each of the cathodes is shaped substantially like a cone.
9. A method of manufacturing a field-emission electron source comprising: a

substrate, an insulating layer that is formed on the substrate and has a plurality of openings, cathodes arranged at the respective openings to emit electron beams, a lead electrode formed on the insulating layer to control emission of the electrons from the cathodes; and a surface-modifying layer formed on the surface of each of the cathodes emitting the electrons, comprising a chemical bond between a cathode material composing the cathodes and a material different from the cathode material, the method comprises:

etching the surface of each cathode in order to remove an oxide film formed on the cathodes; and

forming a surface-modifying layer by a plasma treatment on the cathode surface, the surface-modifying layer comprising a chemical bond between the cathode material and the material different from the cathode material.

10. The method according to claim 9, further comprising:

removing a impurity deposit layer from the surface-modifying layer by etching with a reactive gas containing at least oxygen.

11. The method according to claim 10, wherein the impurity deposit layer comprises a fluorocarbon layer.

12. An image display apparatus comprising:

an electron gun arranged inside a vacuum container and provided with the field-emission electron source according to claim 1; and

a phosphor layer to be irradiated with the electron beam emitted from the electron gun.

13. The image display apparatus according to claim 12, further comprising a deflector for deflecting the electron beam, wherein the electron beam deflected by the deflector is radiated on the phosphor layer.